

REFERENCE 5

SITE NAME Diamond Shamrock Ringville Works  
SITE ID 50HD900611909

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EVALUATION OF DIAMOND SHAMROCK  
SITE, PAINESVILLE, OHIO

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TABLE OF CONTENTS

	<u>Page No.</u>
1.0 Introduction	1
2.0 Disposal Site Characteristics	2
2.1 Surface Drainage	2
2.2 Geology	3
2.3 Hydrogeology	5
2.4 Soils	7
2.5 Chromate Waste Locations	8
3.0 Data Gaps	10
3.1 Contamination Boundries	12
3.2 Surface Water	13
3.3 Fly Ash and River Sediments	13
3.4 Groundwater	14
4.0 Remedial Actions Presently Employed by Diamond Shamrock	17
5.0 Remedial Actions	21
5.1 Cutoff of Surface Drainage	23
5.2 Contaminated Groundwater Collection and Pumping	25
5.3 Treatment of Contaminated Groundwater	25
5.4 Surface Drainage	25
5.5 Site Monitoring and Maintenance	26
REFERENCES	28
APPENDIX	32

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LIST OF TABLES AND FIGURES

	<u>Page No.</u>
Table 1. Water Balance Data for Diamond Shamrock Painesville, Ohio	6
Table 2. Initial Costs for Recommended Remedial Action	22
Table 3. Annual Costs for Recommended Remedial Action	22
Figure 1. Drainage Pattern for Diamond Shamrock Production and Waste Management Areas (Post Diamond Shamrock Remedial Action)	4
Figure 2. General Locations of Suspected Chromate Residues Disposal Areas	9
Figure 3. General Location of Chromate Wastewater Treatment and Disposal Areas	11
Figure 4. Approximate Area Currently being Capped	16
Figure 5. Cross Sectional Diagram of Clay Cap Under Diamond Shamrock's Remedial Program.	19
Figure 6. Approximate Locations of the Proposed Slurry Wall	24

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## 1.0 INTRODUCTION

At the request of the U.S. EPA, JRB Associates undertook a study to analyze the remedial actions being employed by Diamond Shamrock Chemical Company at their "Chromate Residues" disposal areas at the Painesville, Ohio location. To develop a thorough understanding of the remedial action employed by Diamond Shamrock JRB reviewed several key documents provided by the EPA, visited the Painesville facility, and collected supplemental information from the U.S.G.S. library. Results from the review process were used to establish the following:

- development of a chronology of events from start-up till present
- delineate chromate waste boundaries
- identify data gaps in prior studies and verify additional informational needs
- evaluate remedial actions employed by Diamond Shamrock
- recommend additional remedial actions.

The remedial actions recommended by JRB are based solely on the available information provided to us by the EPA. During the review of this information several data gaps concerning the waste management practices and the physical site characteristics were identified. It is therefore reasonable to assume that our recommended remedial actions are not entirely comprehensive with respect to [all the waste management areas at the Painesville facility.] It is our opinion that to develop a comprehensive remedial action program, a sophisticated survey of the waste management practices and the controlling physical characteristics surrounding the facility must be conducted.

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## 2.0 DISPOSAL SITE CHARACTERISTICS

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The Diamond Shamrock Chemical Company's Painesville facilities are located in the Allegheny Plateau on the Southern Shore of Lake Erie and the northern bank of the Grand River at latitude N 41°45' 00" and longitude 81°15'00" near Painesville, Ohio. The chromate waste disposal area<sup>is</sup> are located south of the Diamond Shamrock production facility (on both sides of the Grand River) extending west to (Fairport Harbor) and East to the UNIROYAL property line. Because of its relative position to two major water bodies and the relief of the surface topography the disposal of hazardous waste in this area requires meticulous care.

## 2.1 SURFACE DRAINAGE

The drainage pattern at the Diamond Shamrock facility can be attributed to the natural relief of the land and to the construction activity during the erection of the production facility and waste management areas. The drainage divide between Lake Erie and the Grand River bisects the Diamond Shamrock Production areas and parallels closely the Lake Erie shoreline. The surface drainage pattern for the waste management area<sup>x</sup> either flows directly to the river, or indirectly by meandering around or leaching through earthen dikes and natural barriers. *Cause?*

Presently Diamond Shamrock, as part of <sup>its</sup> remedial action plan, is filling and contouring along the north bank of the Grand River, thus continuously altering the ~~old~~ drainage pattern. The present remedial action plan involves the capping and regrading of Waste Lake No. 2 ~~the old chromate~~

*and the chromate waste disposal area.*

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production facility, the east Impounding Basin, and the Milk of Lime Pond <sup>are used for water in treatment.</sup> Once completed a large portion of the surface run-off <sup>should</sup> be

directed to the storm water drainage system associated with state Road

535. <sup>What?</sup> A crown will be constructed in the south central portion of the

Waste Lake No. 2, causing surface run off to flow to a (drainage basin.) ?

This drainage basin is located on the northern edge of a dike, which parallels the Grand River and extends to the Milk of Lime Pond, where the surface drainage eventually migrates to the river. Areas along the north bank of the river and the extreme boundaries of the Waste Lake No. 2 and waste management areas mentioned above will be covered with fly ash, capped with clay, and countoured toward the Grand River (See Figure 1).

The surface drainage from the west detention basin, Waste Lake No. 3, and Waste Lake No. 4 remains uncontrolled. A majority of the run off from these waste areas is allowed to flow directly to the river.

## 2.2 GEOLOGY

The geology of the area surrounding the Diamond Shamrock facility consist of thin alluvium deposit overlaying a thick deposit of Wisconsin glacial till and lacustrine deposits of Quaternary age. Underlying the glacial till is the Ohio Shale, which is relatively underformed and dips in a northerly direction towards Lake Erie.

Well logs recorded during the installations of monitoring wells surrounding the <sup>system</sup> (Limited Research Chemical) waste disposal site indicate the presence of approximately 13 feet of yellow silty clay, with occasional pockets of sand and gravel. This deposit is underlain by approximately 60' of blue clay to silty clay loam which are interrupted by sporadic lenses of gray sandy silt. The well logs indicate the Ohio Shale

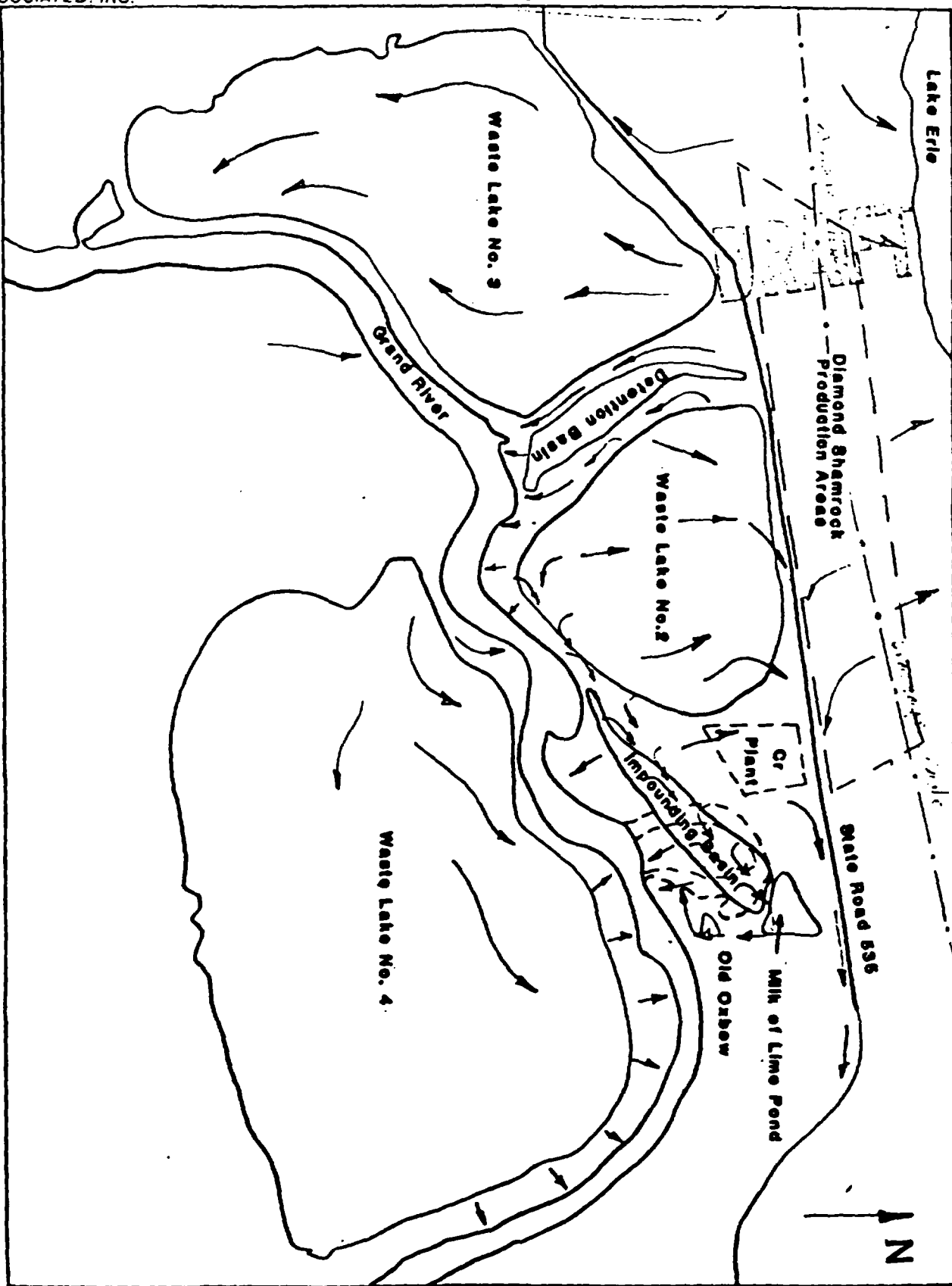


Figure 1: Drainage Pattern for Diamond Shamrock  
Production and Waste Management Areas  
(Post Diamond Shamrock Remedial Action)

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8

System is encountered at depth of 70' to 75' from the surface. Non-continuous well logs recorded at monitoring wells surrounding waste Lake No. 2 and the ~~east~~ <sup>chemical site</sup> ~~Impounding Basin~~ present a similar overburden stratigraphy. However, the textural classification of the unconsolidated till and lacustrine deposits are represented by a larger percent of sandy to silty sand content than recorded in the Limited Research Chemical waste dump well logs.

### 2.3 HYDROBIOLOGY

The approximate arrangement of the bedrock and overburden beneath the site indicates 60ft. of lacustrine and till deposits overlay a vertically fractured shale system. During the winter, spring and other extended wet periods net infiltration is greatest and the static water level ranges from 0 to 10 inches below the surface (See Table 1). Surface permeability varies but is generally rapid and run off is slow. Records indicate that the groundwater resources in this portion of Lake County and their utilization is limited because of low yields.

Herren Consultants performed permeability tests on samples collected in the overburden and the results indicate a flow rate through these unconsolidated sediments ranges from  $4 \times 10^{-6}$  cm/sec. to  $2 \times 10^{-3}$  cm/sec. The wide variation in infiltration rates through the overburden can be attributed to its heterogeneity, because of the lenses of sand and gravel which are interspersed between the clay sediments. It has been suggested that the flow direction of the groundwater in the overburden at the waste site is toward the Grand River and is most likely recharging the river water supply.

TABLE 1

Water Balance Data for Diamond Shamrock Painesville, Ohio

Parameter #	Month											
	J	F	M	A	M	J	J	A	S	O	N	D
P (Ave. An. 26")	.00	.00	.3	1.3	3.3	4.9	5.0	5.0	3.4	2.0	.05	.00
	2	2	3	4	4	4	3	3	3	3	3	2
R/O	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20	.20
R/O	.4	.4	.6	.8	.8	.8	.6	.6	.6	.6	.6	.6
	1.6	1.6	2.1	1.9	-.1	-1.7	-2.6	-2.6	-1.0	.4	1.9	2.4
Neg (I-PET) inches/ft.				(0)	-.1	-1.8	-4.4	-7.0	-8.0			
(Table C)	2.0	2.0	2.0	2.0	1.9	1.4	.9	.5	.5	.6	1.3	1.9
ST	0.0	0.0	0.0	0.0	-.1	-.5	-.5	-.4	0.0	0.1	0.7	0.6
E T	0.0	0.0	.3	1.3	3.1	2.7	1.9	2.0	3.4	2.0	0.5	.00
E R C	1.6	1.6	2.1	1.9	0	0	0	0	0	0.3	1.6	0.8
Temp. F°	28°	28°	35°	47°	58°	68°	70°	72°	63°	55°	40°	30°
Precipitation	2"	2"	3"	4"	4"	4"	3"	3"	3"	3"	3"	2"
(45)	0	0	.19	2.17	4.98	8.16	8.85	9.57	6.58	4.14	.83	.00
adjust PET	0	0	.01"	.04"	.09"	.13"	.13"	.14"	.11"	.07"	.02"	."
adjust PET	0	0	.3"	1.3"	3.3"	4.9"	5.0	5.0	3.4	2	.05	.00

\* The parameters are as follows: PET, potential evapotranspiration; P, precipitation;  $C_{R/O}$  surface runoff coefficient; R/O, surface runoff; I, infiltration; ST, soil moisture storage;  $\Delta$  ST, change in storage; AET, actual evapotranspiration; PERC, percolation.

# All units express in inches.

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16

The Ohio Shale System has been reported to exhibit maximum yields of approximately 5 gpm from joints and cracks. Because of the relative dip of the bedrock it is likely that the groundwater within this system is migrating toward Lake Erie through the reported joints and cracks. It is also assumed that the blue clay overlaying the shale system will act as a confining layer resulting in artesian condition within the bedrock aquifer.

The general dynamics of the tidal action in Lake Erie have been observed in the currents of the Grand River. This tidal action serves to complicate the local groundwater system by possibly shifting the hydraulic gradient during tidal shifts. During high tides in the lake, the river level rises, thus causing groundwater levels near the river to rise and causing a subtle shift in the hydraulic gradient. The subtle shift in the groundwater gradient could temporarily alter the groundwater flow direction.

#### 2.4 SOILS

Soils in the Diamond Shamrock disposal area are classified as (1) Conneaut-Painesville and (10) Tioga-Euclid-Orrville series. The Conneaut-Painesville series soils are described as nearly level and gently sloping, poorly drained and somewhat poorly drained soils that formed on glacial till or loamy materials over silty glacial till; they are generally located on the lake plain. Tioga series soils are nearly level, well drained and somewhat poorly drained. They represent soils formed in alluvial deposits, on flood plains, and terraces. Fuller identified the soils at the waste site as being the Tioga series with small areas of Tyner Vavient sandy loam on raises and Red Hook soils in depressions.

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## 2.5 CHROMATE WASTE LOCATIONS

Diamond Shamrock began its Standard Chromate Division operation in 1931 in a facility located on the Northeast border of Waste Lake

No. 2. The Chromate production operation remained essentially unchanged until shutdown in 1972, at which time the plant was dismantled and sold for scrap. The production process for chromates resulted in the generation of two of the waste streams:

- o A solid residue from the leaching process
- o Process wastewater.

Both waste streams contain high concentrations of hexavalent chromium, a suspected human carcinogen.

According to aerial photographs compiled by the EPA, suspected solid chromate residues have been dumped in the following areas (See Figure 2):

- o Along the northeast boundry of Waste Lake No. 3
- o On both sides of the northern neck of the west Detention Basin
- o Throughout the northern section and at a specific area in the southwest tip of Waste Lake No. 2
- o In and surrounding the east Impounding Basin.

Diamond Shamrock has reported that approximately three quarters of a million tons of these residues were generated at the chromate plant and dumped over an area of about 30 acres in the northeastern section of Waste Lake No. 2. During grading operation in 1974-1975 some of the residues were pushed over into the western portion of the Waste Lake. Based on the Diamond Shamrock information and the data compiled from the aerial photographs chromate residues have been distributed over a large area of

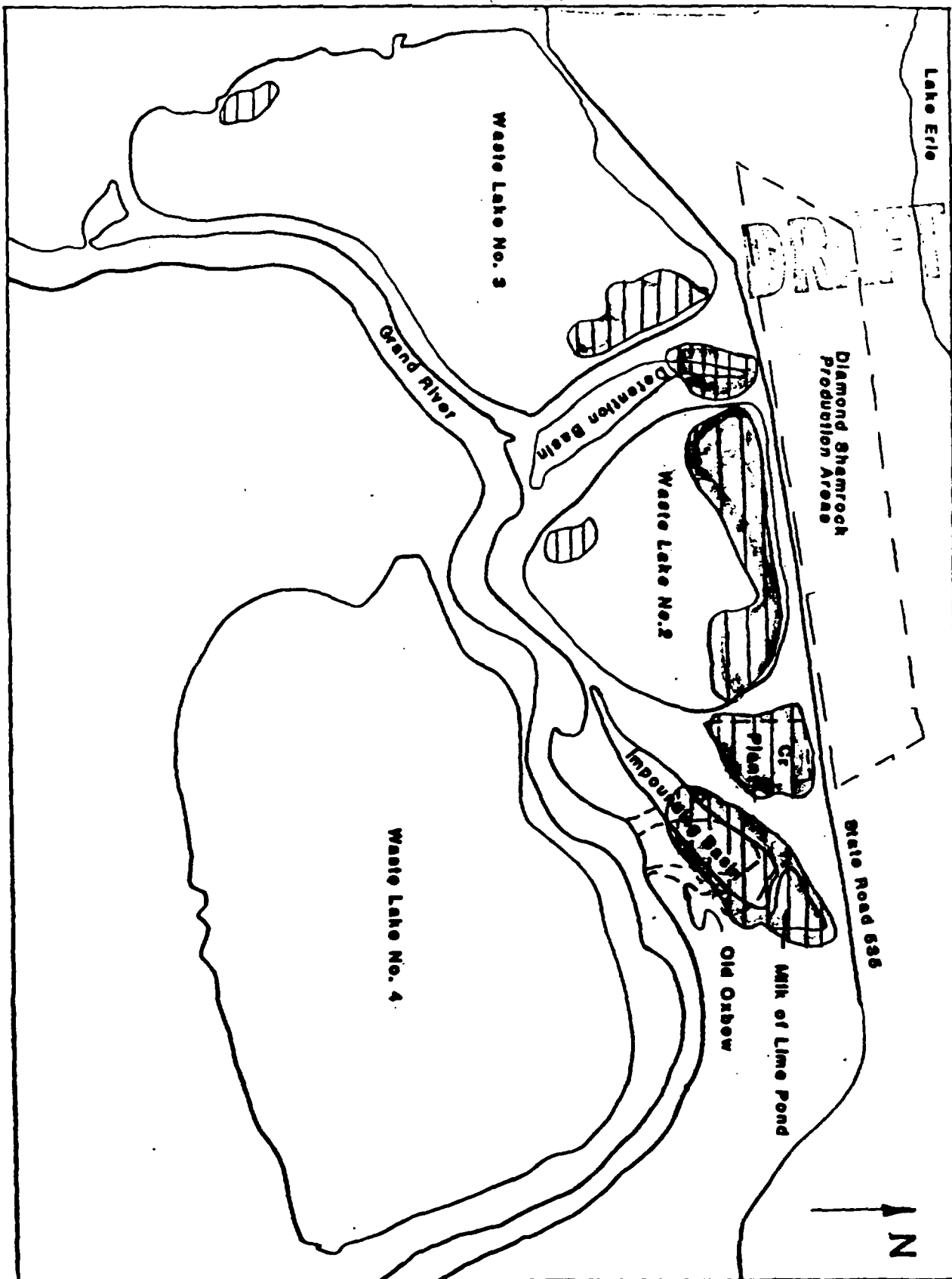


Figure 2: General Locations of Suspected Chromate Residues Disposal Areas

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13

the waste management facility.

The chromate wastewater were disposed of in two general locations after treatment. Initially the chromate plants proces wastewater were discharged to the Milk of Lime Pond to precipitate chromium before discharge to the river. The Impounding Basin located adjacent to the Milk of Lime Pond acted as a run off collection facility for surface drainage from the residue disposal area, and as a detention pond for the chromate plant's wastewater when the treatment facility was not operating (See Figure 3). In 1967 Diamond Shamrock modified the treatment procedures for the chromate wastewater by employing waste pickle liquor as a reducing agent and then comingling the waste stream with calcium carbonate waste from the solvay process in Waste Lake No. 4 to precipitate the chromates. This remained the method of treatment until operations ceased in 1972. The information reviewed to date indicates that chromate wastewaters were never discharged directly to the Grand River without treatment.

### 3.0 DATA GAPS

During the review of the documents supplied to us by the U.S. EPA several data gaps were identified. These missing bits of information are essential in conducting a thorough evaluation of the contamination extent and potential of the Diamond Shamrock facility. In order to provide an effective and long term remedial action plan it is absolutely necessary to understand all aspects of the waste management practices and the contamination potential at the site. It is therefore recommended that the data gaps discussed in this chapter be researched thoroughly prior to full implementation of any additional remedial actions.

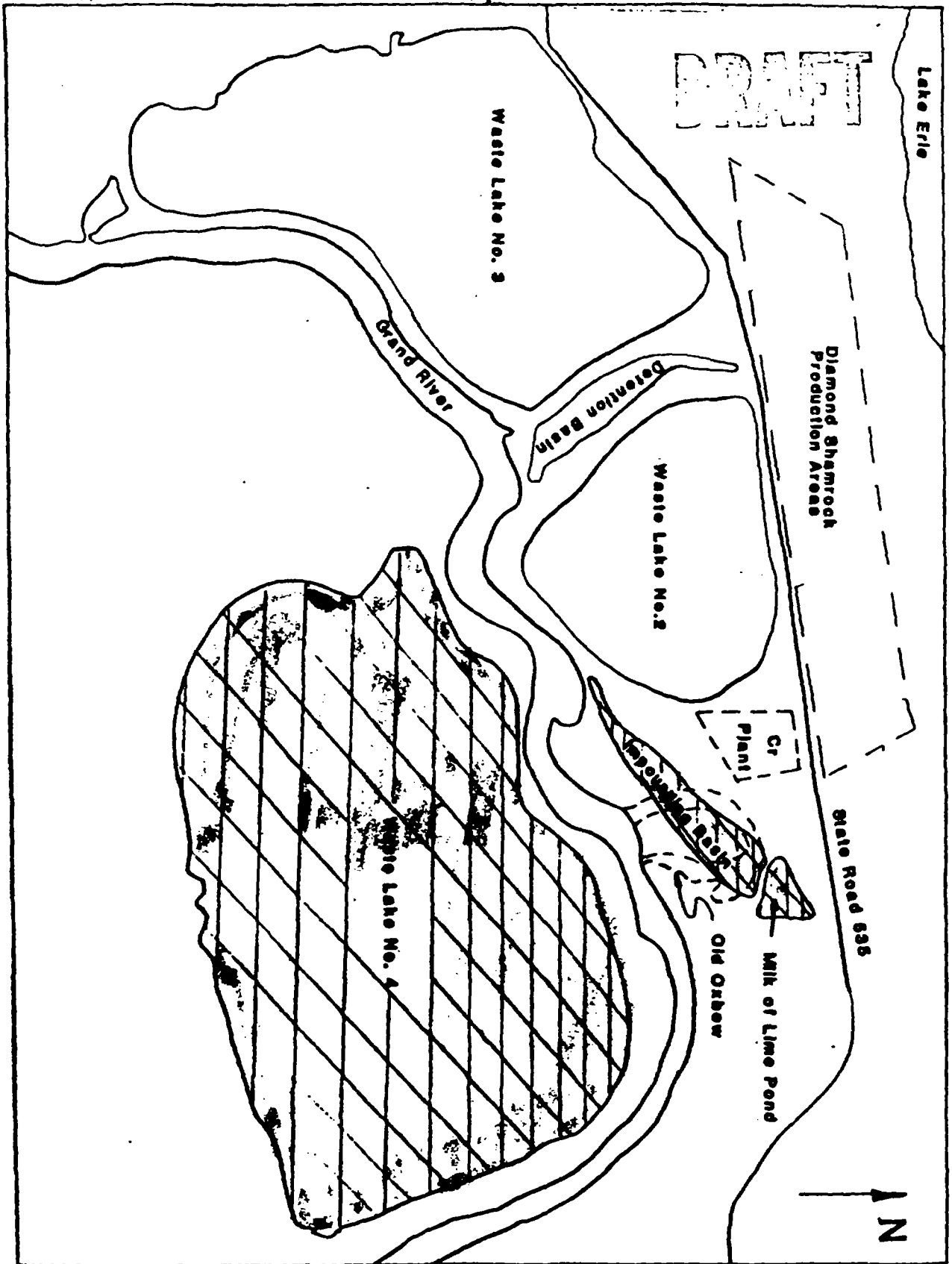


Figure 3: General location of Chromate Wastewater Treatment and Disposal Areas

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15

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### 3.1 CONTAMINATION BOUNDRIES

According to the documentation, contamination boundries were established by utilizing aerial photographs, sporadic soil samples, records provided by Diamond Shamrock, and by observations during brief site visits. At best these techniques will result in a general qualitative understanding of the waste management practices and boundries at the facility.

The contamination areas of Waste Lake No. 2. and eastward have been adequately delineated but little emphasis has been assigned to waste management areas south and west of Waste Lake No. 2. For example, aerial photographs recorded the presence of suspected chromate residues in the northern neck of the west Detention Basin and in two locations in Waste Lake No. 3. However, little field evidence, such as soil samples, have been presented to indicate that the waste boundries in these areas have been investigated and quantitatively identified.

Documentations provided by Diamond Shamrock reports that chromate wastewater was discharged in to Waste Lake No. 4 beginning 1967 and until operations ceased in 1972. No evidence has been collected to varify the potential or nature of contamination resulting from the discharge of these wastewaters to Waste Lake No. 4.

*Waste Lake #3*

Finally the chlorine production at the Chlor-Alkali facility resulted in the discharge of asbestos and possibly mercury waste into the west detention Basin. The discharge was generated during the routine wash down of the mercury cells and then directed to the Detention Basin. The present remedial actions do not address all of the suspected contaminated areas mentioned above and therefore do not show a holistic solution to the waste management problem at the Diamond Shamrock facilities.

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16

### 3.2 SURFACE WATER

Several water quality investigations have been conducted along the Grand River to determine the presence of chromates upstream, adjacent, and downstream of the facility in the river. The results of these numerous investigations have been the compilation of conclusive evidence which indicates that chromates have and are entering the Grand River from the Diamond Shamrock waste sites. To accurately quantify the amounts of chromate wastes entering the river at suspected point and non-point discharge areas more indepth sampling is recommended, especially during peak discharge periods such as heavy storm events. Specific attention should be given to leachate seeps, springs, and intermittent streams along the north and south side of the river. The sampling program should be continued well past the implementation of the remedial actions to record its effectiveness and provide early warning of breaches in the design; thereby, allowing time to implement more effective remedial actions.

### 3.3 FLY ASH AND RIVER SEDIMENTS

The Diamond Shamrock remedial action includes the filling of areas that they have identified as chromate contaminated with approximately 3 to 6 feet of fly ash. Appatently two types of fly ash are being spread over the chromate waste areas identified by Diamond Shamrock. Little evidence has been collected concerning the physical properties of the fly ash, and because its purpose is to act as a barrier to upward migration of chromates, properties such as particle size distribution and permeabilities should be verified occasionally. Without this information the effectiveness of the fly ash barrier cannot be adequately determined.

Because of the tremendous volumes of uncontrolled chromate contaminated runoff allowed to reach the Grand River, contamination of the river sediments

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is suspected. However, no evidence has been collected to assess the potential contamination of the bottom sediments in the river with respect to chromates. It is suggested to insure a thorough investigation that sediment samples be collected and analyzed for chromate contamination upstream, adjacent to runoff originating from the waste areas, and downstream of the facility. This will clarify the extent of contamination in the river and aid in properly evaluating the effectiveness of the remedial action.

### 3.4 GROUNDWATER

Two monitoring well networks have been installed at the Diamond Shamrock facility; the first surrounding the limited Research Chemical landfill is comprised of four wells; the second circumventing three sides of Waste Lake No. 2 and part of the east Impounding Basin, is comprised of eleven wells. After reviewing the data generated from the second monitoring network, which was constructed to evaluate chromate contamination, it is obvious that groundwater contamination from chromates has occurred in specific areas within the site. However, a thorough understanding of the groundwater contamination problem and the hydrogeologic system cannot be developed from the information generated by these monitoring networks because of the data gaps explained below:

- the well logs supplied by Herron Consultants were recorded for certain segments of the well and not the entire well length
- no information was supplied describing the well construction techniques and well development methods, including approximate depth of the screens.
- the areal extent and design of the groundwater monitoring network is insufficient to provide the data necessary to accurately model the plume(s) of contamination.

Because well logs were not recorded for the entire length of the monitoring wells it is impossible to develop an accurate account of the overburden stratigraphy. Without a complete stratigraphic description it is difficult to anticipate the likely routes of chromate movement in the overburden and bedrock. Complete well logs are also necessary when describing the relationship between the bedrock and sedimentary deposits hydrogeologic regimes. By understanding this relationship we can assess the dynamics of the bedrock and overburden hydraulics and their effect on the design of the remedial action plan.

When constructing and developing a monitoring well, certain engineering standards must be recorded in order to properly utilize groundwater monitoring data. It is absolutely necessary to know the depth of the well screens and the stratigraphic units in which they are set, otherwise, as in the case of the Diamond Shamrock facility, uncertainties exist as to which formation the static water level readings are being registered. Without this information it is difficult to predict the direction of groundwater and contaminant movement in the hydrologic regime for either formation beneath the site. Finally, without data on the well construction and development techniques employed by the driller it is difficult to evaluate the integrity of the monitoring wells, and thus the analytical results from these wells could be classified as suspect.

A key element to any groundwater monitoring network which is providing data to be used in the design of remedial actions is it's effective areal extent. The network at the Diamond Shamrock facility is sufficient to detect the presence of groundwater contamination, but falls short of supplying enough data to design a holistic remedial action plan. The

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19

present groundwater monitoring network is clustered around Waste Lake No. 2 and the east Impounding Basin and by concentrating the monitoring network like this two important bits of information were overlooked:

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- the network does not monitor the potential for groundwater contamination in Waste Lake No. 3, the west Detention Basin, and Waste Lake No. 4
- the locations of the monitoring wells are such that an accurate groundwater divide in the overburden between Lake Erie and the Grand River is not established; and the subtle effects of tidal action in Lake Erie on the static water level of the local hydrogeologic regime is not registered.

#### 4.0 REMEDIAL ACTIONS PRESENTLY EMPLOYED BY DIAMOND SHAMROCK

The remedial program presently under construction by Diamond Shamrock consists primarily of clay capping, re-contouring re-vegetating the site. The area of chromate disposal affected by this remedial plan is approximately shown in Figure 4 .

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Chromate wastes which were originally deposited near the banks of the Grand River have been moved back to the area shown in Figure 4 (See Section 2.0 for a description of waste disposal practices). The current capping procedures consist of:

- o Construction of a dike along the southern edge of Waste Lake No. 2 (See Figure 4 );
- o Fill in Waste Lake No. 2 and the impounding basin area with up to 6 feet of fly ash;
- o Cover the entire capped area with a minimum of 1 foot of clay, and;
- o Cover the clay with topsoil and seed with clover, vetch, and ryegrass.

A cross-sectional diagram of the clay cap is shown in Figure 5. Based upon the current literature it is unclear as to what the final capping and contouring configuration will be. However, several problems may surface with time if this cap is the only remedial measure used at the site. These problems could include:

- o Migration upward of soluble chromate waste through capillary action;
- o Settling of the fly ash fill, resulting in depressions in the cap and/or (depending upon the thickness of the clay) cracking of the cap itself;

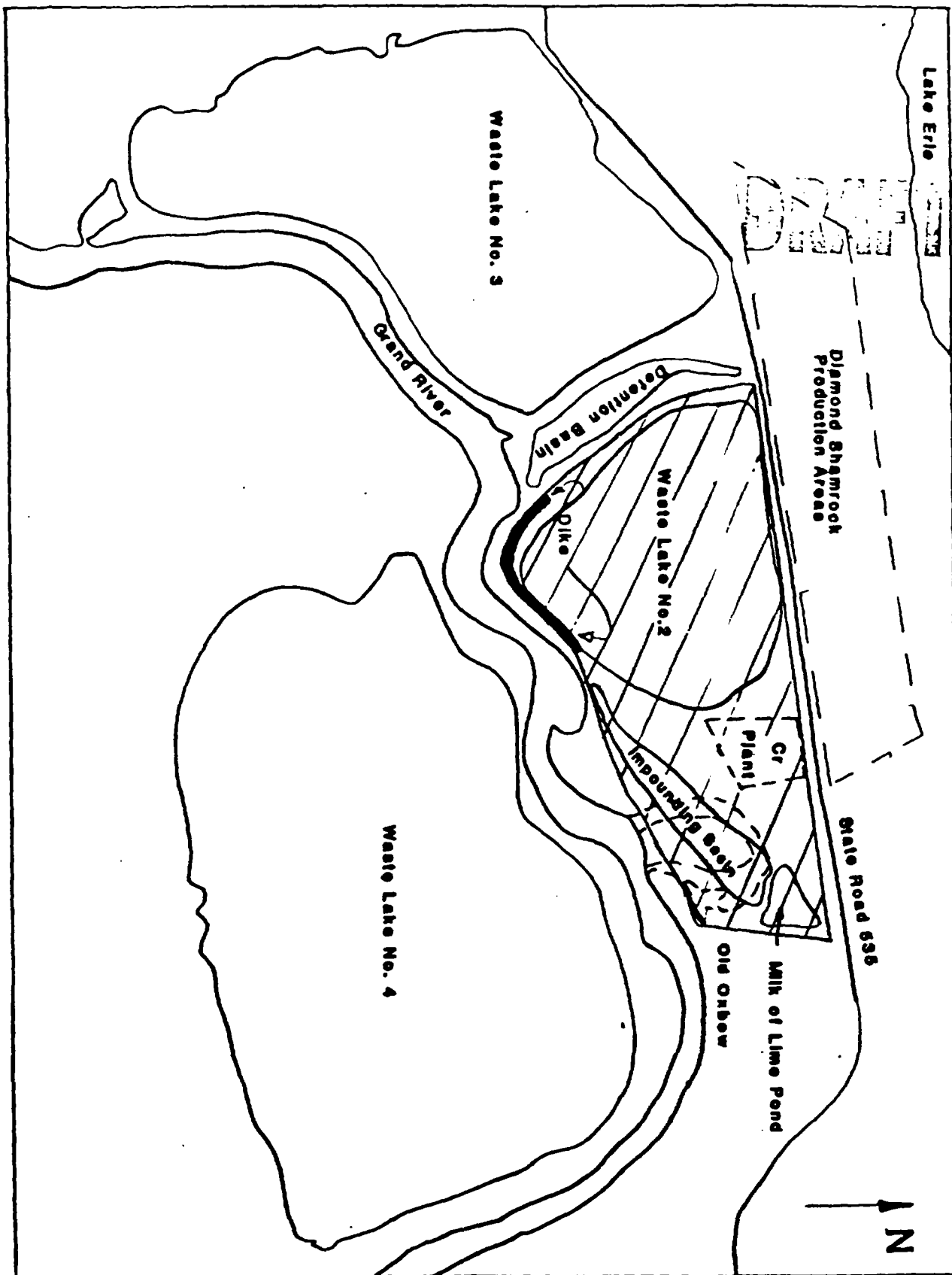


Figure 4. Approximate Area Currently Being Capped

Clay Cap Area

Clover Vetch & Ryegrass

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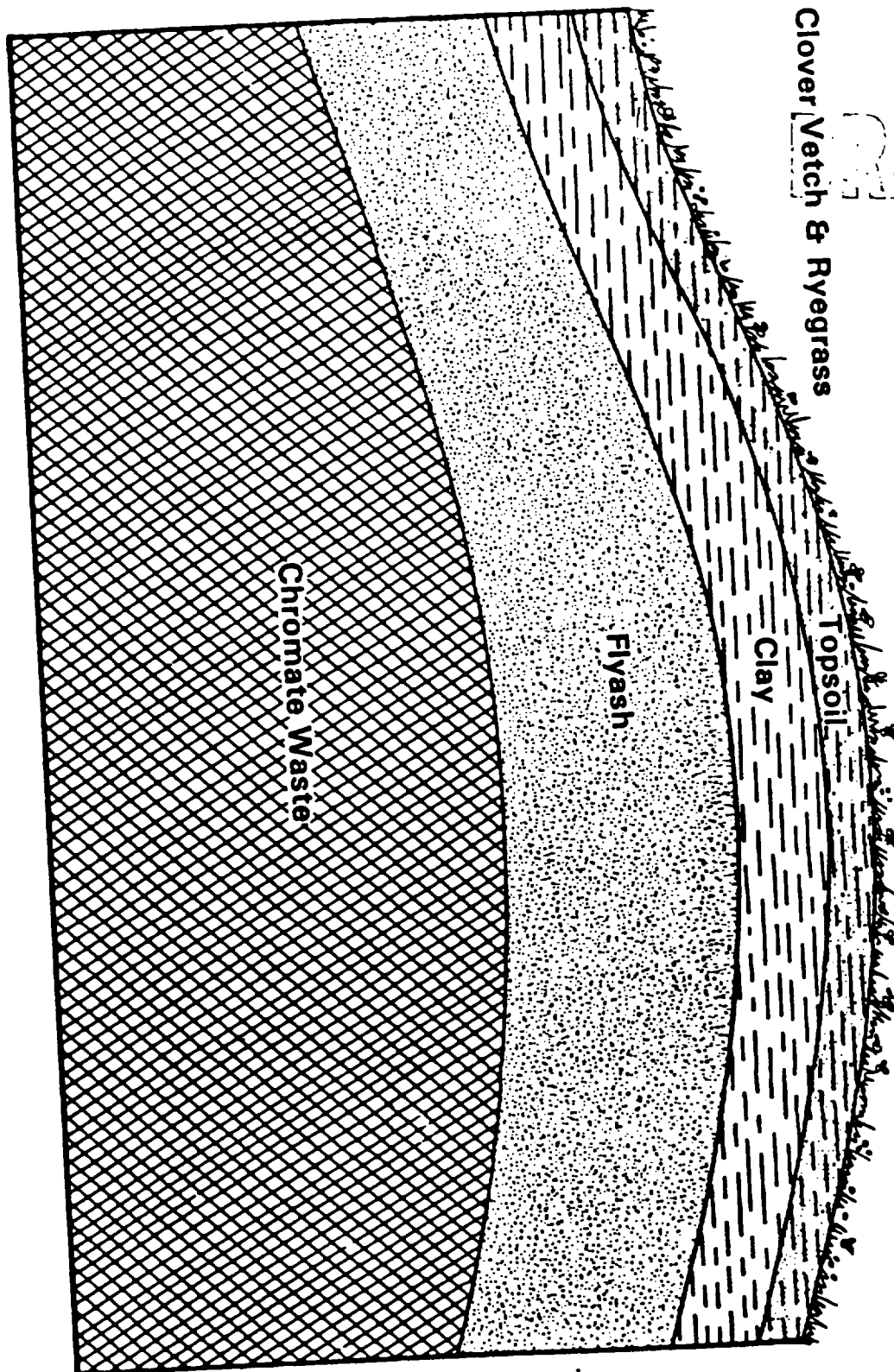


Figure 5. Cross Sectional Diagram of Clay Cap Under Diamond Shamrock's Remedial Program.

- o continual groundwater contamination from soluble chromate waste.

#### DISCUSSION:

The primary purpose of clay capping a waste disposal site is to prevent the generation of leachate through the downward migration of precipitation through the soil. This procedure works as a stop gap measure in the prevention of leachate generation only if the waste is buried far above the seasonal high water table. If groundwater is allowed to contact the waste during any period of time, it then becomes necessary to take steps in addition to capping to prevent leachate generation.

Fly ash, when used as a fill, will not totally retard the upward migration of soluble chromate waste and will only act as a temporary barrier. How long the fly ash fill will retard the upward migration of soluble waste is dependant upon its chemical composition and particle size distribution. It will be impossible to make this determination without further information.

Section 5 discusses what measures should be implemented in conjunction with clay capping, to ensure that groundwater contamination is held within the boundaries of the site.

## 5.0 REMEDIAL ACTIONS

Based on our review of available data discussed in previous sections, and our knowledge of remedial measures planned and already performed at the site, we believe that additional measures are necessary to prevent migration of wastes to the Grand River. These measures include cutoff of subsurface drainage migrating from the site to the Grand River, removal and treatment of contaminated groundwater and control and treatment of surface drainage. A summary of recommended remedial actions and their associated costs as given in Tables 2 and 3

Recommended remedial actions address those areas known or suspected to contain wastes from the old Diamond Shamrock production facility. These were shown previously on Figure 2. The costs shown in Tables 2. and 3. do not reflect additional remedial actions that may be necessary, but cannot be discussed completely due to lack of information. These include:

- o Dredging of potentially contaminated sediments in the Grand River
- o Addressing potential contamination due to Waste Lake No. 4.
- o A thicker cap than that intended by Diamond Shamrock, placed according to specifications used in other EPA enforcement actions.

Grand River sediments have apparently not been sampled and analyzed, although it is likely that they are contaminated. Dredging of these sediments and safely disposing of dredge spoils would be very costly, particularly if contamination were found all the way to Lake Erie.

Waste Lake No. 4 apparently received chrome-containing wastewaters for the period 1967 to 1972. Remedial actions have not been proposed for

Table 2. Initial Costs for Recommended Remedial Action

Capping	(Cost to be determined-see text)
Slurry Trench	\$2,370,000
Contaminated Groundwater Collection	221,000
Pumping, Treatment and Discharge	<u>330,000</u>
	\$2,921,000

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Table 3. Annual Costs for Recommended Remedial Action

Sampling and Analysis	\$ 56,000
Operations, maintenance and chemicals for contaminated groundwater treatment	100,000
Site inspection and maintenance	<u>196,000</u>
	\$352,000

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26

this area due to a lack of data showing that contaminants (particularly  $Cr^{+6}$ ) are migrating.

The cap recommended for the site is the same as that agreed to by a Company involved in another EPA enforcement case. The recommended cap consists of:

- o Three feet of clay, compacted in six-inch layers to a maximum permeability of  $1 \times 10^{-7}$  cm/sec.
- o One six - inch layer of sand tilled into the clay
- o One six - inch layer of topsoil seeded with native vegetation.

The following are more detailed explanations of the proposed remedial actions.

#### 5.1 CUTOFF OF SUBSURFACE DRAINAGE

According to available information, the dikes used to form waste lakes at the site were not keyed into impervious clay layers underlying the site. Therefore, we believe that a major pathway for migration of wastes was to exit the site between the bottom of the dike and the underlying clay layer. Therefore, the recommended remedial action includes construction of a slurry trench cut-off around the sides of the site as shown in Figure 6. To be effective, the cut-off should be placed partially into the blue clay layer underlying the site.

Although depth of this layer from the surface is not available from enough well logs or soil boring data to define completely it appears that an average depth of 25 feet can be assumed based on the scattered data that is available. Length of the slurry trench will be about 14,000 feet.

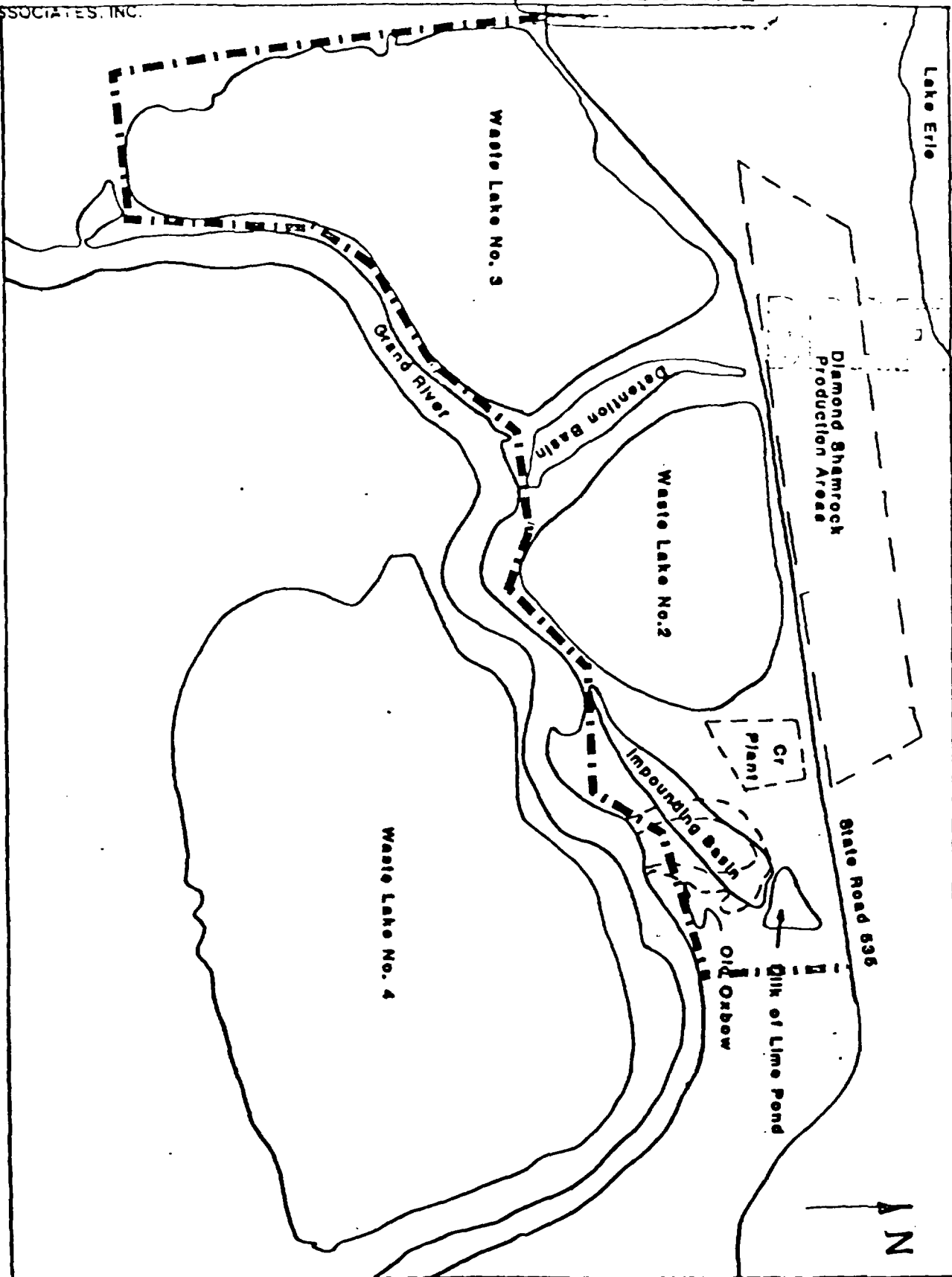


Figure 6. Approximate Locations of the Proposed Slurry Wall.

## 5.2 CONTAMINATED GROUNDWATER COLLECTION AND PUMPING

Contaminated groundwater, once prevented from exiting the site by the slurry wall, must be collected for pumping to the surface and treatment. A drain tile system is recommended for this purpose based on experience with its use and its proven effectiveness. The system will consist of drain tile with coarse gravel in it to allow free passage of liquids. The tile will be installed to an average depth of about 25 feet, which is the same as that for the slurry trench cutoff. The collection system will also run about 14,000 feet. The system will collect groundwater above the 25 foot depth. The drain tile will be sloped to three collection points for pumping of contaminated groundwater to the surface for treatment.

## 5.3 TREATMENT OF CONTAMINATED GROUNDWATER

Contaminated groundwater is expected to contain chiefly hexavalent chromium as the problem contaminant. Treatment of contaminated groundwater will include:

- o Reducing hexavalent chrome to trivalent by adding a reducing agent, such as sulfur dioxide, to wastewaters that have been acidified to a pH of about 3.5
- o Increasing pH to the 7 to 8 range to form insoluble chromium hydroxide
- o Removing chromium hydroxide by settling or filtration and disposing sludge in a secure landfill
- o Discharging treated wastewaters to the Grand River.

## 5.4 SURFACE DRAINAGE

If the cap is constructed and maintained according to the recommendations given previously, likelihood of contaminating surface drainage is small.

However, we recommend that surface runoff be monitored and if contamination

is found, then additional treatment facilities must be constructed.

#### 5.5 SITE MONITORING AND MAINTENANCE

These activities include:

- Periodic sampling and analysis of groundwater, surface runoff discharged to the Grand River, and the Grand River itself
- Operations and maintenance of the leachate collection and treatment system
- Chemicals for treating contaminated groundwaters
- Inspection and maintenance of the cap and slurry wall.

Sampling and analysis activities include the following:

- Monthly monitoring of surface runoff for chromium contamination
- Daily monitoring of untreated and treated groundwater
- Monthly monitoring of chromium contamination in the Grand River.

Inspection and maintenance of the cap and slurry wall include the following:

- Inspection for cracks, depressions and other breaches and repairing them
- Maintaining the vegetative cover
- Inspection for seeps and other signs of contamination.

In summary we have formulated a remedial action plan to address site problems based on available information. These recommended actions should be updated as additional information is gathered. As an example, a thorough investigation of the location of contamination may lead to a recommendation that the area which undergoes remedial action be increased or decreased. Additionally, if the areas that are contaminated prove to

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be larger or smaller than the 310 acre area used in this study, then alternative remedial actions may be considered. A smaller contaminated area may lead, for example, to a recommendation that waste be excavated and removed to a secure hazardous waste site.

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APPENDIX

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Chronology of Events

Listed below is a simple chronology of events at the Diamond Shamrock Painesville facility derived from information collected from Diamond Shamrock, the State of Ohio, the U.S. EPA, and responsive contractors. The listing reports the events which transpired as a result of disposing waste from the production of chromates and in some cases other commercial products. An attempt was also made to list remedial actions which were considered or actually implemented by Diamond Shamrock.

- 1912: Diamond Shamrock starts operations by producing sodium carbonate (solvay process), Coke, chlorinated paraffins.
- Oct. 1931: Start up of the production of chromates including: sodium dichromate, potassium dichromate and chromic acid.
- Chrome production:
- Process water was treated and released to the river
  - Residues from the leaching operation were dumped by rail car in open piles near Waste Lake No. 2.
  - Diaphragm cells wash water from chlorine and caustic production is disposed of in the hydroretention basin west of Waste Lake No. 2.
  - Waste Lakes 1 thru 4 were built for soda ash waste disposal.
- 1940-54 Diamond Shamrock conducted studies which indentified high concentration of Hex chrome entering the river.
- 1950 Brumbaugh of Diamond Shamrock (D.S.) suggested to grout the dike at Waste Lake No. 2 to plug seepage to river. Also collect and treat run off from the ore pile. (not carried out?)

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34

- 1953-54 Diamond Shamrock dries up Waste Lake No. 2 in a attempt to reduce the amount of chrome entering the river.
- 1954 Special program initiated by D.S. to study the effects of leaching from the oikes at Waste Lake No. 2 after drying it up.
- Oct. 1954 Mr. Jarvis of D.S. questions whether the state should be informed about the chromate problem. Evendently the state was not informed.
- 1963-1970 A one acre site with pits 15'-20' deep and 8'-10' wide was used to dispose of limited research quantities of chemical. The site is clay lined and has groundwater monitoring wells surrounding it. *1 acre landfill*
- 1967 Chrome production process waters were treated with pickle liquor and release to Waste Lake No. 4.
- 1972 Residue hexavalent chrome was disposed at Waste Lake No. 2 after shut down of the chromate plant. The residue was spread over the surface of the waste lake.
- 1974-1975 The Waste Lake No. 2 was graded and covered with a 6 inch clay cap.
- 1976-1980 D.S. is in the process of covering Waste Lake No. 2 with fly ash at three six feet thick, a clay cap at approximately one foot thick, and excavating several chromate "hot spots."
- 1977 State approve a reclamation plan - fly ash & clay cap.
- 1979 Application for a permit for reclamation of the waste disposal site submitted.
- 1980 Herron Consultants installed 11 monitoring wells around the site. The locations were selected by D.S.